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Fashion Augumented Reality Try-On System using Pose Estimation

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Abstract

The fashion industry's shift towards digital solutions has spurred the development of innovative tools to enhance customer engagement. This project presents a web-based augmented reality (AR) try-on application that allows users to see how garments appear on them in real-time through their device's camera. By utilizing OpenCV for body detection and garment mapping, the system offers precise virtual clothing overlays, providing shoppers with a realistic and interactive trial experience without visiting physical fitting rooms.

Key features of the application include an extensive clothing catalog, AI-driven outfit suggestions, and useful shopping tools like a cart system, social media sharing, and the option to save favorite outfits. By streamlining the shopping process and minimizing dependence on traditional fitting rooms, this platform enhances user convenience, offering a faster and more engaging retail experience.

Keywords: Augmented Reality, Virtual Try-On, OpenCV, Fashion Retail, AI Recommendations.

1. Introduction

The growing reliance on online shopping has significantly impacted the fashion retail industry. E-commerce platforms provide customers with convenient access to a vast range of clothing options; however, they fall short in replicating the physical shopping experience, particularly the ability to try on garments before purchase. This gap often results in uncertainty regarding clothing fit, color, and style, which can ultimately lead to dissatisfaction, product returns, and reduced customer trust in online platforms. This problem has become more pronounced with the rapid increase in digital shopping trends, demanding innovative solutions aiming to unify the physical and virtual retail environments.

One prominent challenge faced by customers is the risk of purchasing clothes that do not meet their expectations. Since size charts and product descriptions may vary across brands, customers often find it difficult to predict how a garment will appear when worn. Consequently, high return rates pose a considerable challenge for both consumers and retailers. Addressing this issue requires an effective solution that enhances the user's ability to make informed decisions while improving the overall shopping experience. To overcome these challenges, we present a web-based augmented reality (AR) try-on system that enables users to visualize garments on themselves in real-time using their device's camera. By leveraging computer vision techniques with OpenCV, the system effectively detects the user's body and maps virtual clothing with precision. This interactive solution allows shoppers to try on outfits digitally, empowering them to make confident purchase decisions.

The proposed system offers several features to enhance the user experience. It includes a detailed clothing catalog where users can browse various items, filter them by categories such as color, size, and occasion, and view their appearance in real-time. Additionally, the system provides AI-powered outfit recommendations based on user preferences to assist customers in finding suitable combinations. To improve convenience, users can save their preferred outfits, share their try-on experiences via social media, and utilize a cart system for streamlined purchases.

While the system provides an engaging and immersive shopping experience, one limitation is that minor inaccuracies in garment positioning may occur during rapid user movement. Future improvements will aim to address this issue by enhancing body detection precision and improving garment alignment. The overall architecture comprises three key components: a user interface that offers an intuitive platform for browsing and trying on outfits, a backend system for managing clothing data and user information, and a computer vision module powered by OpenCV that drives the AR functionality. This modular design ensures seamless performance across multiple platforms, providing users with a smooth and effective shopping experience. By integrating augmented reality technology into the fashion retail industry, this system addresses key challenges in online shopping, offering a more interactive and accurate method for users to visualize clothing and make confident purchasing decisions.

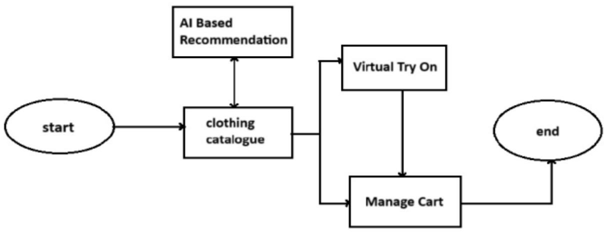

Figure 1: Overview of the System

Figure 1 represents a general overview of web application where the user uses AI recommendations for fashion selection and selects clothes that he/she would like to try and add those clothes in cart virtually. Thus, this paper describes the implementation of web application for virtual try-on and AI recommendation using technology like OpenCV to create a better shopping experience.

2. Literature Survey

In recent years, Virtual Try-On (VTO) technology has grown in popularity, as it offers a more interactive and personalized online shopping experience by letting users see how clothes might look on them before they buy. Several studies have explored different approaches to implementing VTO systems, each presenting unique challenges and advancements. Image-based VTO systems have been prominent in the field, with notable work such as VITON, which uses a two-stage approach to align clothes with a person's body in a photo while preserving body pose and structure [1][2]. However, such systems often struggle with retaining fine details, especially around body contours and clothing textures [6].

To address these limitations, several approaches have focused on improving structural coherence and detail preservation. For instance, DP-VTON proposes a multi-level warping approach that integrates both feature-based and pixel-level transformations to enhance clothing detail while preserving non-target body parts, significantly improving the visual realism of virtual try-ons [3]. Another significant contribution is from Sun et al., who propose using human parsing techniques to retain the body structure, ensuring that the final virtual try-on image is both realistic and accurate [4]. Augmented Reality (AR) has also emerged as a promising technology for virtual try-on systems. Marker-based AR techniques, for instance, allow real-time body detection and the superimposition of clothing on the user's image, providing an immersive and interactive shopping experience [6][7]. This approach leverages tools like OpenCV to detect body features and align garments in real time [8]. On the other hand, 3D-based methods, although more computationally expensive, offer better fitting simulations by using accurate body scans and cloth modeling [5].

The integration of these technologies into mobile platforms has made VTO systems more accessible and cost-effective, with mobile applications now able to perform tasks like cloth simulation and real-time rendering with reduced computational overhead [5]. Despite these advancements, challenges remain in creating systems that can accurately model fabric properties, adapt to various body shapes, and offer a seamless user experience [10][2]. As VTO technology evolves, combining AR, deep learning, and real-time simulation will likely provide a robust solution to these challenges, setting the stage for the future of online apparel shopping.

In addition to image-based and AR solutions, other innovative approaches have been introduced. For instance, Cao et al. focused on combining virtual try-on with computational simulations for educational purposes, specifically targeting clothing thermal functional design (CTFD). This work uses virtual-wear trials that go beyond visual simulations, integrating the thermal properties of clothing into the virtual try-on process [9]. Furthermore, Zhu et al. developed a mobile-based VTO system that focuses on achieving realistic garment fitting with low-cost, real-time simulation algorithms, enhancing the user experience while managing computational resources effectively [5].

This review explores the main techniques and challenges in virtual try-on systems, tracing the development from traditional image-based approaches to more sophisticated augmented reality and 3D simulation technologies.

3. System Architecture

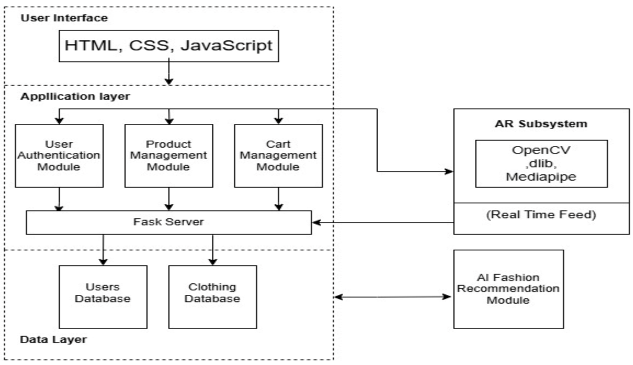

Figure 2: System Architecture

The proposed AR Fashion E-Commerce Web App aims to transform the online retail experience by integrating augmented reality (AR) technology with conventional e-commerce capabilities. The system is organized into three principal layers—Presentation Layer, Application Layer, and Data Layer—supplemented by a dedicated AR Subsystem to support real-time user interactions.

A. Presentation Layer

This layer represents the front-end interface where users engage with the platform. Developed using HTML, CSS, and JavaScript, it offers a user-friendly and responsive design. Shoppers can browse apparel, utilize the AR try-on function, and manage their shopping cart with ease. A key feature of this layer is the integration of a live camera feed, which empowers users to virtually try on garments, helping to improve purchasing confidence and reduce product returns.

B. Application Layer

The Application Layer is responsible for the system's core functionality, organized into the following modules:

- User Authentication: Ensures secure access, enabling personalized user experiences.
- Product Management: Handles creation, updating, deletion, and display of clothing items.
- Cart and Checkout Management: Supports adding items to the cart and processing transactions.
- Camera Input Handler: Collects live video input for AR processing.

This logic is managed through a Flask-based backend, which acts as a mediator between the front end and back end, ensuring efficient communication and functionality across the system.

C. AR Subsystem

The AR Subsystem utilizes libraries such as OpenCV, MediaPipe, and dlib to interpret and process the real-time camera stream. Its responsibilities include:

- Pose Detection: Captures and analyzes user body positions to align digital clothing accurately.
- Image Segmentation: Differentiates the user's figure from the background, enabling realistic garment overlays.
- Virtual Try-On Engine: Simulates the fitting of clothes directly on the user's frame, replicating an in-store experience.

D. Data Layer

This layer manages the system's storage and data retrieval operations. It consists of:

- User Data Repository: Maintains user profiles, shopping history, and preferences.
- Product Database: Stores detailed clothing information, including 3D models and fabric textures.
- AI-Based Recommendation System: Utilizes behavioral data and current fashion trends to offer personalized outfit suggestions, thereby enhancing user engagement and satisfaction.

This system is founded on key principles such as augmented reality, modular architecture, and real-time computer vision processing. By integrating these technologies, the platform bridges the experiential gap between digital and physical shopping. Challenges such as sizing concerns and the absence of tactile interactions are addressed through interactive visualization and AI support. Furthermore, the use of RESTful APIs via Flask ensures scalability and ease of integration, while the recommendation engine supports retention and conversion through intelligent data analysis.

This structure not only improves user engagement but also aligns with current innovations in online retail, making the platform a forward-thinking, immersive, and scalable e-commerce solution.

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4. Methodology

E. Web Application

To address common challenges such as long queues at trial rooms and limitations in traditional virtual try-on solutions, our project introduces a web-based AR fashion try-on application. This platform offers a range of features designed to improve the online shopping experience:

a. Users begin by signing into the system for secure access. Upon logging in, they are asked to provide basic details like height and weight, which are used to recommend appropriate clothing sizes for a better fit.

b. Once signed in, users can browse through an extensive catalog of clothing options. The platform also includes a search bar, enabling users to filter items based on color, style, or occasion, simplifying the process of finding suitable outfits.

c. Users can add their chosen garments to a virtual cart, which not only helps in organizing selections but also displays the total estimated cost of the selected items, ensuring transparency during checkout.

d. The standout feature of the platform is the AR-based virtual try-on functionality. Users can visualize how the selected outfits would appear on them in real-time, providing a realistic view of garment fit and style. Moreover, the platform features a recommendation bot that offers tailored clothing suggestions based on user preferences, body measurements, and current fashion trends. This personalized guidance assists users in making well-informed decisions when selecting outfits.

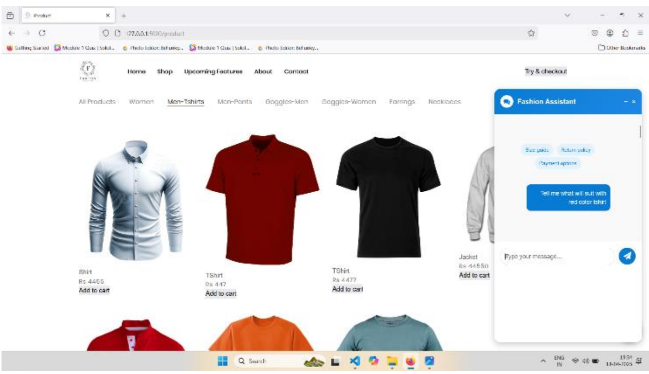

Figure 3: User Interface

F. Database

Figure 4 presents a screenshot of the database, illustrating how user login information is managed in the relational database. The database contains several key attributes for storing user details:

a) Name – Represents the user's full name.

b) Password – Stores the user's password securely.

c) Gender – Records the user's gender.

d) Height – Captures the user's height information.

e) Weight – Stores the user's weight details.

These attributes collectively help manage user profiles efficiently within the system

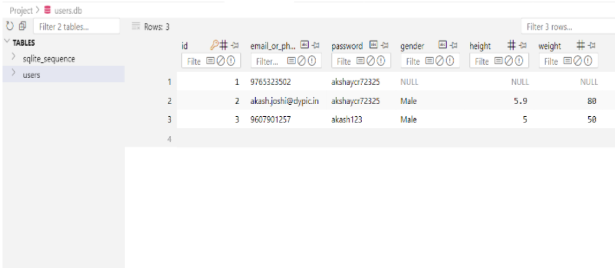

Figure 4: User Database

G. Recommendation Bot

The chatbot is built using Flask, a lightweight web framework in Python, and leverages the Open Router API for generating intelligent responses. The application starts by initializing the Flask framework and defining a secret key for session management, ensuring secure data handling. A global variable CART is defined to manage selected items during the user's shopping experience.

The chatbot functionality is defined within the /chatbot route, which listens for POST requests. When a user sends a message, it is extracted from the request's JSON data and printed for debugging purposes. The application then prepares a payload containing the user's message and relevant instructions for the chatbot. In this case, the chatbot's role is defined as a fashion assistant, guiding users on fashion choices. The specified model used in the payload is "deepseek/deepseek-r1:free", which is optimized for conversational tasks.

The system sets HTTP headers that include the Open Router API key and content type to ensure secure and structured data transmission. The chatbot then sends the prepared payload to the Open Router API endpoint, where the AI model processes the request and generates an appropriate response. This response is extracted, printed for debugging, and returned to the client in JSON format.

To ensure robustness, the code includes error handling to catch potential issues during API communication. If the request fails, the error is logged, and the user receives a message indicating that the system couldn't process their query. This comprehensive design allows the chatbot to effectively provide fashion recommendations, improving the user experience by offering personalized suggestions based on their queries.

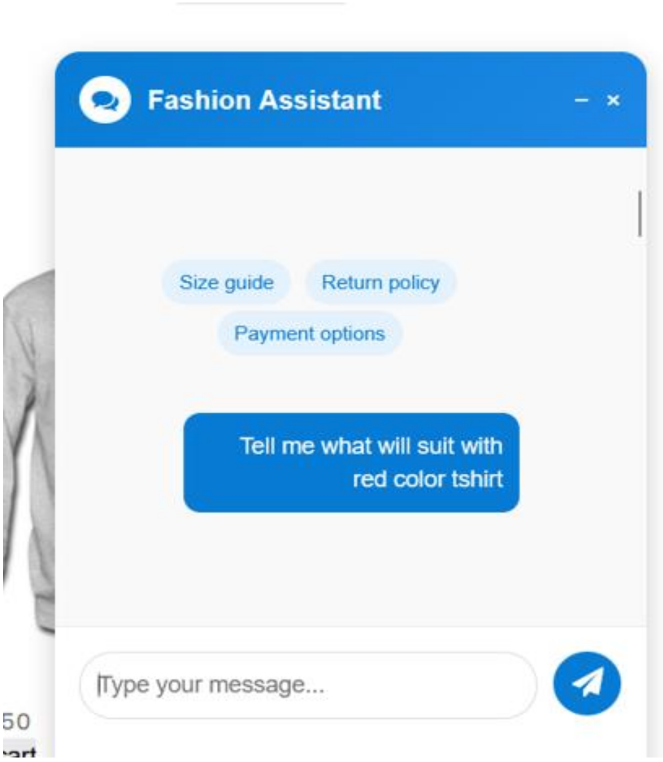

Figure 5: Recommendation Bot

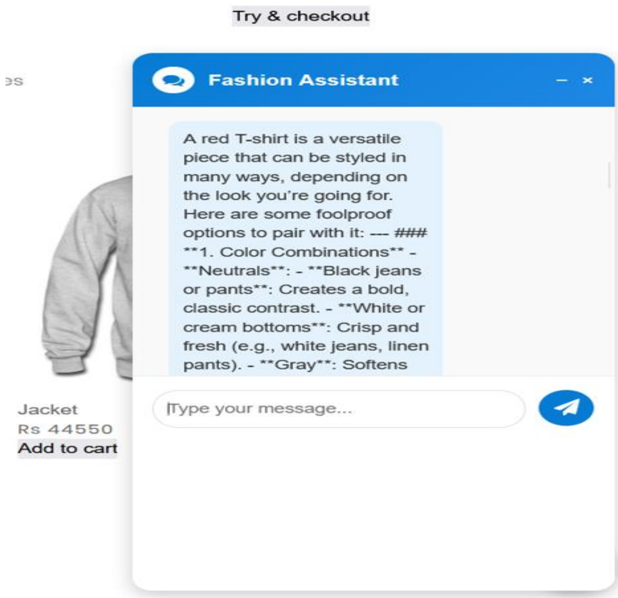

Figure 6: Recommendation Bot

Figure 5 & 6 shows the screenshot of recommendation bot giving appropriate response and suggestion regarding fashion sense to the user because the user was asking about the suggestions

H. Pose Estimation

The pose estimation methodology in this project utilizes Haar Cascade classifiers combined with coordinate mapping techniques to accurately position virtual clothing on the user's body. The process is structured in several stages to ensure effective detection and alignment.

1. Image Acquisition: The system captures the user's live camera feed, which serves as the input for the pose estimation model. Each frame is processed in real-time to ensure dynamic interaction during the virtual try-on experience.
2. Preprocessing: To enhance detection accuracy, the captured image undergoes preprocessing steps such as grayscale conversion, noise reduction, and contrast adjustment. Converting the image to grayscale simplifies the feature detection process, reducing computational complexity.
3. Feature Detection Using Haar Cascade Classifiers: Haar Cascade XML files are employed to detect key body landmarks, particularly the face and upper body. The classifier scans the image in multiple scales using a sliding window approach. By recognizing distinct patterns such as facial outlines, eyes, and shoulders, the system determines the approximate body position.
4. Landmark Mapping: Upon detecting key features, the system maps critical body points, such as the shoulder area, neckline, and upper torso. These mapped points serve as anchor coordinates for positioning the virtual clothing.
5. Virtual Garment Overlay: Using the mapped landmarks, the selected clothing item is resized and adjusted to align proportionally with the detected body features. This ensures that the clothing appears realistic and well-fitted on the user's body.
6. Recommendation System Integration: The system integrates a fashion recommendation bot that assists users by suggesting suitable outfits based on their detected body features, preferences, and current fashion trends. This enhances the overall shopping experience by providing personalized recommendations.
7. User Interaction and Feedback: Users can try on multiple outfits, seek recommendations, and visualize combinations in real-time. The system allows for continuous refinement, ensuring the virtual garment accurately adjusts to user movements for a seamless experience.

This methodology effectively combines lightweight detection techniques like Haar Cascade classifiers with strategic mapping processes to provide a responsive and engaging virtual try-on experience. By utilizing efficient algorithms and intuitive design, the system ensures both accuracy and performance in real-world scenarios.

I. Algorithm

Input**:** RGB frame It at time t, sprite set S={S1,…, Sk}

Output: Augmented frame 'It′ with virtual items

1. Face Detection and Alignment:
   a. Convert It to grayscale:

      Igray←RGB2Gray(It)

   b. Detect faces:

c. For each face $f_i \in F$:

i. Predict landmarks: $L_i \leftarrow$ predictor (I_{gray}, f_i)

ii. Compute head inclination:

2. Body Pose Estimation:

a. Process It with Media Pipe Pose:

b. Extract key points:

3. Dynamic Sprite Placement:

For each active sprite $S_j \in S$:

a. If S_j is face-aligned (e.g., glasses):

i. Calculate position:

ii. Apply affine transform:

$S_j' \leftarrow \text{rotate\_scale}(S_j, \theta_i, w)$

b. If S_j is body-aligned (e.g., pants):

i. Compute dimensions:

$width \leftarrow \| hipL - hipR \|_2 \times 1.2$

$height \leftarrow \| hipL - ankleL \|_2 \times 0.9$

ii. Position:

4. Alpha Compositing:

For each sprite S_j' at (x_j, y_j):

$$I_t'(x, y) \leftarrow \alpha S_j'(x - x_j, y - y_j) + (1 - \alpha) I_t(x, y)$$

where α is the sprite's transparency channel.

5. Return **It′.**

RESULTS

The application was tested by users to evaluate its effectiveness in real-world scenarios and to obtain accurate results.

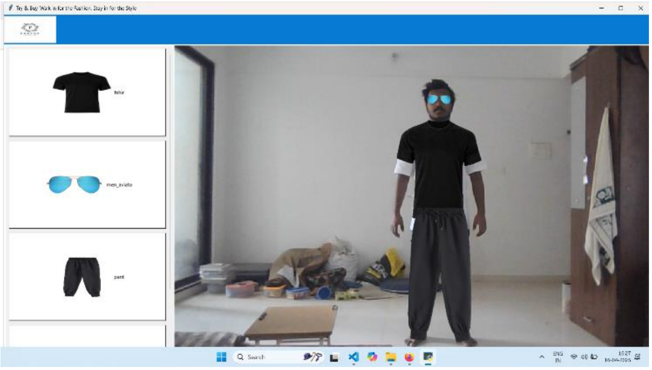

Figure 7: T-shirt and pant mapping

Figures 7 to 9 display screenshots of the person mapping process. In Figure 7, a black t-shirt and black track pants are used for mapping, while in Figure 8, an orange t-shirt with blue jeans is shown. The individual is positioned approximately eight feet away from the camera, resulting in effective mapping. The mapping is flawless around the edges, it provides a clear visualization to help users decide whether to purchase the clothing.

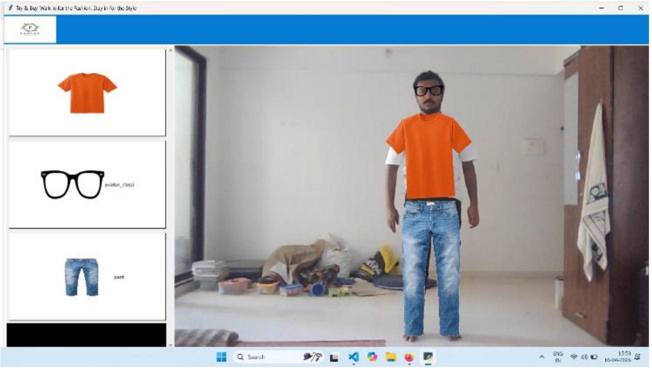

Figure 8: T-shirt and jeans Mapping

This system allows users to visualize various types of clothing in virtual reality, enabling them to experiment with different outfit combinations. Additionally, the virtual try-on feature supports adding multiple items to the cart, giving users the convenience of trying on several clothes at once. This flexibility allows users to take their time and make well-informed decisions about their clothing choices.

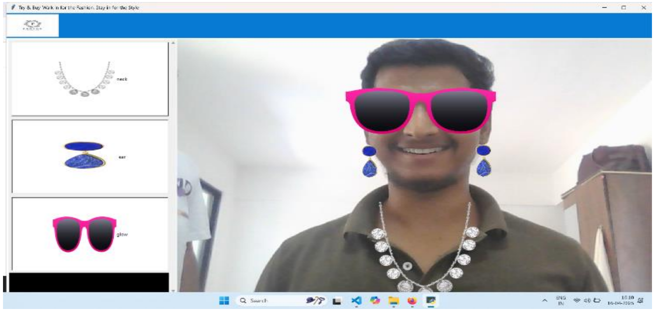

Figure 9: Necklace, Earring and Goggles Mapping

In addition to clothing, the system successfully supports the virtual try-on of fashion accessories such as goggles, earrings, and necklaces. As illustrated in Figure 9, the system accurately detects facial landmarks like the eyes, nose, and ears using lightweight pose estimation techniques. Based on these keypoints, virtual accessories are dynamically aligned and overlaid in real time. Goggles are positioned with respect to the eyes and nose bridge, ensuring realistic placement without visual distortion. Earrings are mapped using detected ear coordinates, while necklaces are adjusted according to the neckline and upper torso points. This functionality enhances the overall shopping experience by allowing users to visualize not only apparel but also complementary accessories, enabling a complete virtual styling experience.

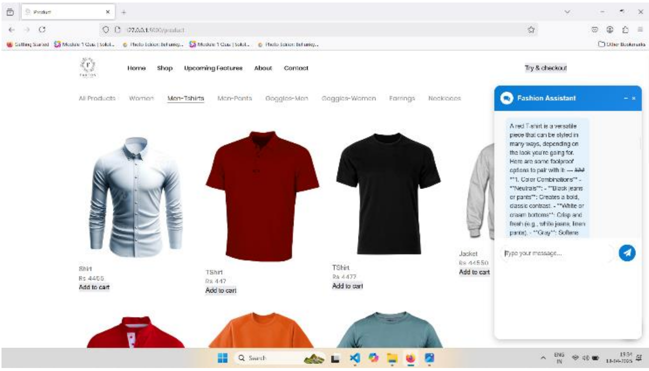

Figure 10: Recommendation System

Figure 10 showcases the recommendation bot, which acts as a reliable fashion advisor, providing helpful guidance for making stylish choices. This feature assists users in selecting appropriate clothing styles and colors, reducing confusion and simplifying the decision-making process.

6. Applications

The AR-Based Fashion Try-On system offers a wide range of practical applications, particularly in the fashion and retail industries. E-commerce platforms can integrate this technology to enhance their online shopping experience, allowing customers to visualize how garments will look and fit on their bodies. This feature helps reduce product returns, as users can make more informed purchasing decisions. Fashion brands can also use this system for virtual fitting rooms, allowing users to virtually try on clothing, removing the need for in-store visits, offering greater convenience, and appealing to tech-oriented consumers who enjoy immersive and interactive shopping.

Beyond retail, this system can be beneficial in fashion design and styling. Designers can use the AR interface to visualize their creations on digital models, making it easier to refine designs without needing physical samples. Personal stylists can leverage the system to curate outfit suggestions for clients based on their preferences and body types. Additionally, the system can be integrated into social media platforms, enabling users to share their virtual try-on results with friends, thus promoting brands through user-generated content. With its versatility, the AR-Based Fashion Try-On system holds immense potential in transforming both online shopping and fashion design landscapes.

7. Future Enhancement

To enhance this AR-Based Fashion Try-On system, several innovative upgrades can be implemented. Incorporating 3D body scanning technology can significantly improve the precision of garment fitting, ensuring better alignment with various body shapes. Integrating AI-driven size recommendations can further personalize the user experience by suggesting suitable clothing sizes based on body dimensions and past preferences. Adding features such as a virtual wardrobe will allow users to save and mix-match outfits, improving engagement.

Furthermore, enabling multi-angle views and pose detection can enhance the realism of the AR experience by dynamically adjusting garments based on the user's posture. For performance improvements, adopting cloud-based AR rendering can ensure smoother interactions, especially on devices with limited processing power. Additionally, integrating secure checkout systems and social media sharing features can streamline the purchasing process while encouraging user engagement. These enhancements collectively aim to boost accuracy, performance, and user satisfaction, making the system more robust and future-ready.

8. Conclusion

The AR-Based Fashion Try-On system presents a practical and innovative solution to enhance the online shopping experience. By integrating augmented reality with web-based technologies, the system enables users to virtually try on clothing items in real time, improving decision-making and reducing the need for physical trials. The system’s architecture, combining frontend interfaces with a well-structured backend and AR processing module, ensures efficient functionality and smooth user interactions. Additionally, features like dynamic outfit visualization and real-time garment adjustments enhance user engagement and provide a personalized experience.

This implementation not only simplifies the shopping process but also addresses common challenges faced in online fashion retail, such as uncertainty in size, fit, and style. The modular design of the system allows for easy scalability, making it adaptable for integrating advanced features like AI-based outfit recommendations, 3D body scanning, and improved performance optimization in future developments. With further improvements, this system can significantly contribute to the growth of virtual shopping platforms by offering users a seamless, interactive, and accurate try-on experience, ultimately improving customer satisfaction and boosting sales in the fashion industry.

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